WHAT IS CLAIMED IS:

1. An optical amplification system, comprising:

a laser source generating an input beam having a nearly diffraction limited mode;

a multi-mode fiber amplifier;

a mode converter receiving the input beam and converting the mode of the input beam to match a fundamental mode of the multi-mode fiber amplifier, and providing a mode-converted input beam to said multi-mode fiber amplifier; and

a pump source coupled to said multi-mode fiber amplifier, said pump optically pumping said multi-mode fiber amplifier, said multi-mode fiber amplifier providing at an output thereof an amplified beam substantially in the fundamental mode.

2. The optical amplification system according to claim 1, wherein the fundamental mode is substantially guided by gain-guiding.

3. The optical amplification system according to claim 2, wherein inter-modal scattering from the fundamental mode to any higher-order mode is substantially reduced by gain-guiding of the fundamental mode.

4. The optical amplification system according to claim 2, wherein, as a result of substantial gain-guiding, the size of the fundamental mode in said multi-mode fiber amplifier varies along the fiber length.

5. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier comprises a fiber core, and wherein a dopant is confined in an area in a central section of the fiber core substantially smaller than a total fiber core area.

6. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier comprises a fiber core, and wherein a dopant is confined in an area in a central section of the fiber core substantially smaller than a total fiber core area, and wherein mode-coupling into higher-order modes is reduced by gain-guiding.

7. The optical amplification system according to claim 1, wherein a gain of the fundamental mode is substantially higher than a gain of any other mode present in said multi-mode fiber amplifier.

8. The optical amplification system according to claim 1, wherein a size of the fundamental mode in said multi-mode fiber amplifier varies along

a length of said multi-mode fiber amplifier in accordance with a change in fiber diameter along the length of said multi-mode fiber.

9. The optical amplification system according to claim 1, wherein a size of the fundamental mode in said multi-mode fiber amplifier varies along a length of said multi-mode fiber amplifier in accordance with a change in a core or doped core diameter along the length of said multi-mode fiber.

10. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier is doped with rare-earth-ions.

11. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier is doped with at least one of: Er, Er/Yb, Yb, Nd, Tm, Pr, Ho ions.

12. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier comprises a double cladding structure.

13. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier is polarization maintaining.

14. The optical amplification system according to claim 1, wherein the amplified beam passes through said multi-mode fiber amplifier at least twice.

15. The optical amplification system according to claim 1, wherein the mode-converted input beam comprises optical pulses, wherein nonlinear effects within said multi-mode fiber amplifier broaden a spectrum of the optical pulses.

16. The optical amplification system according to claim 1, wherein the mode-converted input beam comprises optical pulses, the system further comprising a compressor which compresses the optical pulses output from said multi-mode fiber amplifier.

17. The optical amplification system according to claim 1, wherein said mode converter comprises a bulk-optics imaging system.

18. The optical amplification system according to claim 1, wherein said mode converter comprises a tapered single-mode fiber.

19. The optical amplification system according to claim 1, wherein said mode converter comprises a combination of a bulk-optics imaging system and a tapered fiber.

20. The optical amplification system according to claim 1, further comprising:

reflectors disposed to form a laser cavity, said reflectors reflecting energy of the amplified beam along an axis; and

means for coupling the reflected energy of the amplified beam out of the laser cavity.

21. The optical amplification system according to claim 20, wherein said reflectors comprise at least one of: a mirror; a fiber Bragg grating; and a bulk grating.

22. The optical amplification system according to claim 20, further comprising an optical switch disposed within the laser cavity, said optical switch enabling Q-switching of the laser cavity.

23. The optical amplification system according to claim 20, further comprising an optical switch disposed within the laser cavity, said optical switch enabling operation of the laser cavity as a regenerative amplifier.

24. The optical amplification system according to claim 1, further comprising a mode filter receiving the amplified beam and providing a mode-filtered beam.

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25. The optical amplification system according to claim 24, wherein said mode filter is a single mode fiber.

26. The optical amplification system according to claim 24, wherein said mode filter is a spatial filter.

27. The optical amplification system according to claim 1, wherein a number of propagating modes within said multi-mode fiber amplifier is between 3 and 3000.

28. The optical amplification system according to claim 1, wherein a number of propagating modes within said multi-mode fiber amplifier is between 3 and 1000.

29. The optical amplification system according to claim 1, wherein a wavelength of the amplified beam is greater than 1.100 μm.

30. The optical amplification system according to claim 1, wherein said multi-mode fiber is disposed along a straight line and tension is applied along a longitudinal direction of said multi-mode fiber amplifier.

31. The optical amplification system according to claim 1, wherein said multi-mode fiber has a step-index refractive index profile.

32. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier is manufactured by one of: MCVD, OVD, VAD and PCVD fabrication techniques.

33. The optical amplification system according to claim 1, wherein a number of propagating modes within said multi-mode fiber amplifier is higher than 4, and wherein a fiber Bragg grating is written into said multi-mode fiber amplifier.

34. The optical amplification system according to claim 1, wherein a chirped fiber Bragg grating is written into said multi-mode fiber amplifier.

35. The optical amplification system according to claim 1, wherein said laser source comprises a single-mode fiber oscillator.

36. The optical amplification system according to claim 1, wherein at least one pre-amplifier is inserted between said laser source and said multi-mode fiber amplifier.

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37. The optical amplification system according to claim 36, wherein said at least one pre-amplifier is a second multi-mode amplifier fiber, and wherein a single mode is launched into said multi-mode amplifier fiber.

38. The optical amplification system according to claim 36, wherein said at least one pre-amplifier is a single-mode amplifier fiber.

39. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier generates pulses with a peak power greater than 1 kW.

40. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier generates a peak power greater than a ratio of 1 kW/amplifier length.

41. The optical amplification system according to claim 1, wherein optical pulses having a width shorter than 10 nsec are amplified in said multi-mode fiber.

42. The optical amplification system according to claim 1, further comprising a nonlinear optical element disposed downstream of said multi-

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mode fiber amplifier, wherein said amplified beam is frequency converted by said nonlinear optical element.

43. The optical amplification system according to claim 1, further comprising a nonlinear crystal disposed downstream of said multi-mode fiber amplifier, wherein said amplified beam is frequency doubled in said nonlinear crystal.

44. The optical amplification system according to claim 43, wherein said nonlinear crystal comprises a periodically-poled $LiNbO_3$ crystal.

45. The optical amplification system according to claim 43, wherein said nonlinear crystal comprises an aperiodically-poled $LiNbO_3$ crystal.

46. The optical amplification system according to claim 1, wherein an M^2-value of said multi-mode fiber amplifier is less than 10.

47. The optical amplification system according to claim 1, wherein an M^2-value of said multi-mode fiber amplifier is less than 4.

48. The optical amplification system according to claim 1, wherein an M^2-value of said multi-mode fiber amplifier is less than 2.

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49. The optical amplification system according to claim 1, wherein said multi-mode fiber amplifier comprises a cladding with an outside diameter greater than 125μm.

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